APPENDIX 8.9. AIR CONDITIONER OPERATING HOURS

TABLE OF CONTENTS

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8.9.1 INTRODUCTION

A more-efficient blower and/or blower motor design option means that reduced amounts of waste heat from the blower and/or motor will be added to the cooled air stream generated by the air conditioner. This means the air-conditioner operating hours are reduced. Since the annual house cooling load does not change when a furnace with a more efficient blower and/or blower motor is installed, the cooling provided to the house by the heating, ventilation, and air conditioning (HVAC) system must remain the same.

This appendix explains how DOE calculated the reduced air conditioner operating hours for a furnace with a more-efficient blower and/or blower motor design option. The steps in the calculation include determination for: annual house cooling load (HCL), annual air conditioning operating hours, air conditioner capacity, heat amount added by the blower and blower motor, and the impact of new blower and/or blower motor design options.

8.9.2 ANNUAL HOUSE COOLING LOAD

The Department calculated annual house cooling load in Btus as:

$$HCL = RECS_{cool} \times SEER$$

where:

HCL = house annual cooling load (Btu/yr),
$RECS_{cool}$ = house annual cooling energy consumption from RECS97 (kWh/yr),[1] and
$SEER$ = seasonal energy efficiency ratio as described in Chapter 7, section 7.3.3, AFUE and SEER of Existing Equipment (Btu/h/kWh).

8.9.3 ANNUAL AIR CONDITIONER OPERATING HOURS

The annual air conditioner operating hours is given by:

$$ACOH = \frac{HCL}{AC_{cap}}$$

where:

$ACOH$ = annual air conditioner operating hours (hr/yr),
HCL = house annual cooling load (Btu/yr), and

AC_{cap} = cooling capacity of the air conditioner and the furnace blower and motor, as described in Chapter 7, section 7.4.2, Airflow Capacity, (Btu/h).

8.9.4 AIR CONDITIONER CAPACITY

The air conditioner capacity can be thought of as the rate of cooling provided by the evaporator coil minus the rate at which heat is added back to the air stream by the blower and blower motor.

$$AC_{cap} = \dot{Q}_{evap} - \dot{Q}_{blower}$$

where:

AC_{cap} = cooling capacity of the air conditioner and the furnace blower and motor (Btu/h),
$\dot{Q}_{evap}$ = rate of cooling provided by the evaporator coil (Btu/h), and
$\dot{Q}_{blower}$ = rate of heating provided by the inefficiencies of the blower and blower motor (Btu/h).

8.9.5 HEAT ADDED BY BLOWER AND BLOWER MOTOR

The rate of heat added to the air stream by electricity use of the blower motor is:

$$\dot{Q}_{blower} = BE \times 3.412$$

where:

$\dot{Q}_{blower}$ = rate of heating provided by the electricity use of the blower motor (Btu/h),
BE = blower motor power consumption in cooling mode (W),
3.412 = conversion factor (Btu/h/W).

8.9.6 IMPACT OF NEW BLOWER AND/OR BLOWER MOTOR DESIGN OPTIONS

Since the house cooling load is not affected by a new blower and/or blower motor design option, the house cooling load will remain the same with existing and new blower and/or blower motor. This is expressed as:

$$HCL_{exist} = HCL_{new}$$

where:

HCL_{exist} = house cooling load with the existing furnace blower and blower motor (Btu/yr), and

HCL_{new} = house cooling load with the new furnace blower and/or blower motor design options (Btu/yr).

This last equation can be combined with the earlier equations to give:

$$ACOH_{exist} \times \left(\dot{Q}_{evap} - \dot{Q}_{blowerexist}\right) = ACOH_{new} \times \left(\dot{Q}_{evap} - \dot{Q}_{blowernew}\right)$$

which can be rearranged as:

$$ACOH_{new} = \frac{\left(\dot{Q}_{evap} - \dot{Q}_{blowerexist}\right)}{\left(\dot{Q}_{evap} - \dot{Q}_{blowernew}\right)} \times ACOH_{exist}$$

or, with further expansion as:

$$ACOHnew = \frac{\left[\frac{HCL}{ACOHexist} + BEexist \times 3.412 - BEexist \times 3.412\right]}{\left[\frac{HCL}{ACOHexist} + BEexist \times 3.412 - BEnew \times 3.412\right]} \times ACOHexist$$

which can then be further simplified as:

$$ACOH_{new} = \frac{ACOH_{exist}}{1 + 3.412 \times \left(\frac{BE_{exist} - BE_{new}}{AC_{capexist}}\right)}$$

REFERENCE

1. U.S. Department of Energy - Energy Information Administration, *Residential Energy Consumption Survey: Household Energy Consumption and Expenditures 1997*, 1999. Washington, DC. Report No. DOE/EIA-0321(97). <http://www.eia.doe.gov/emeu/recs/recs97/publicusefiles.html>